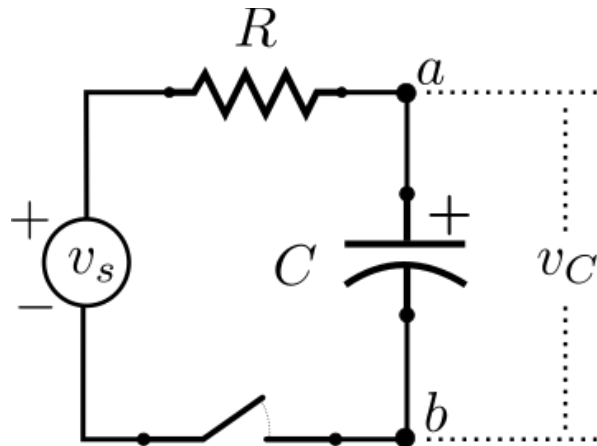
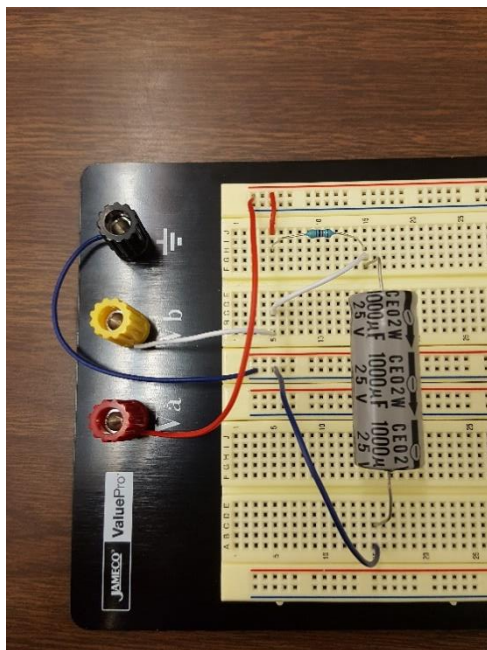


## Challenge 5 Background

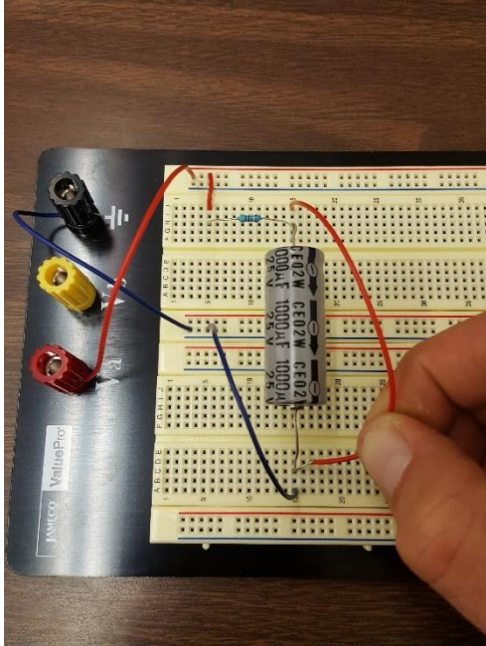
RC circuit diagram (see Transient Circuits Module for more information)



Suggested Breadboard Configuration



Suggested Capacitor Rapid Discharge Method



Note: The electrolytic capacitor must be placed in the circuit with the correct polarity.

#### Ideal Circuit Model and Voltage Response to Step Input

Dynamic Model:  $RC \frac{dv_c(t)}{dt} + v_c(t) = \tau \dot{v}_c + v_c = v_s(t)$

Step input:  $v_s(t) = V_s u_s(t) = V_s \begin{cases} 0, & t < 0 \\ 1, & t \geq 0 \end{cases}$

System Response:  $v_c(t) = (V_{c0} - V_s)e^{-t/RC} + V_s = (V_{c0} - V_s)e^{-t/\tau} + V_s$

Time Constant:  $\tau = RC$

$R$  – Resistance,  $C$  – Capacitance

$v_s(t)$  – Source Voltage,  $v_c(t)$  – Capacitor Voltage,  $u_s(t)$  – Unit Step Function

$V_s$  – Source Voltage Amplitude,  $V_{c0}$  – Initial Capacitor Voltage Amplitude